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*The Meckel Diverticulum.*

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## THE MECKEL DIVERTICULUM.<sup>1</sup>

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I HAVE given the subject of the Meckel diverticulum some research, have had occasion to examine the seventeen specimens in the Army Medical Museum, Washington, D. C., and have tabulated and analyzed nearly two hundred recorded cases.

The characteristics of this diverticulum are well known. It is single ; that is, there is but one in the same individual ; it is usually at right angles to the small intestine, into which it opens ; usually also on the convex side of the intestine (the side opposite the mesentery), although, more rarely, it may be attached laterally or to the mesenteric side ; it is nourished by the mesenteric vessels ; it is usually tubular in shape, but may be globular, or conical, or inversely conical (*i. e.*, with the base at the opposite end from the intestinal attachment) ; its walls are composed of the same coats as the intestine. Its length varies from a very small size to as much as seven inches. It is usually found in the lower part of the ileum, but is said also to have been seen in the higher part, and even in the jejunum and duodenum.

The expressions *true* and *false* diverticulum, often used to distinguish the Meckel diverticulum from those pouches sometimes found as the result of hernial protrusion, are not, to my mind, correct. A diverticulum is so called from its shape and relations. It is either a diverticulum or not ; if it *is* one, it must be a *true* one. The hernial pouches, resulting from inflammation and other causes, had better be called hernial pouches, and not false diverticula, because they are not false diverticula. The Meckel diverticulum is usually spoken of as the Meckel diverticulum, because, although Lavater was the first to record its being observed, and Ruysch the first to call it a diverticulum, John Frederick Meckel was the first to distinguish between the form which goes by his name and the hernial pouches above mentioned. The designation seems to be entirely satisfactory and more desirable than other names, such as the diverticulum ilei, which is open to the objection that it may not always be found in the ileum.

<sup>1</sup> Read before the Association of American Anatomists, at Princeton, N. J., December 27-29, 1892.

Instead of a diverticulum there may be an open canal extending from the intestine to the umbilicus, and may even open at the umbilicus, so that feces may discharge by the opening. There are other cases in which a cord of variable length may pass from the apex or from near the apex of the diverticulum to the umbilicus, or some other part of the abdominal wall; or to one of the viscera, preferably the mesentery; or may lie free in the peritoneal cavity. Struthers, of Edinburgh, states that he always found this ligament present if the specimen was examined while in a moist state; and sometimes the shrunken umbilical vesicle was found in the upper part of the ligament. Sometimes, also, there is a bridge or valve at the intestinal end, making two openings there. Meckel thought that this valvular arrangement was the mode in which the original opening of the ovo-vitelline duct into the intestine began to close.

The last few sentences suggest the probable *cause* of the diverticulum. Ziegler, Wilks, Moxon, Osler, Birch-Hirschfeld, Meckel, Struthers, Quain, Henle, Cazin, Gegenbauer, Allen, and others agree that it is due to a failure of the intestinal end of the ovo-vitelline (omphalo-mesenteric) duct to become obliterated. Some writers speak more doubtfully. Macalister says it is *supposed* to be the remnant, etc. The portion not obliterated develops on the same line as the intestine, that is, acquires similar coats, mucous, muscular, and serous.

In the embryo, as is well known, the yolk-sac and intestine are for some length of time in direct communication through the open abdominal wall; afterward they become separated by the closure of the wall, and are connected then by the canal called the ovo-vitelline, or omphalo-mesenteric, duct. Alongside the duct are the corresponding artery and vein. The usual statement is that the duct communicates with that part of the intestine which later would be called the lower ileum or lower fourth of small intestine. This junction corresponds to the part which forms the *primitive fold* of the intestine, and is near the cæcum. About the sixth week of embryonic life the umbilical vesicle and the duct and vessels begin to wither away, and by the end of pregnancy there remains only a fibrous cord, which may have been broken or undergone fatty or other degeneration. Courty has found the vesicle as late as the fifth month, and Hunter at the end of pregnancy, although no larger than at the second or third month.

Should any disturbing influence interfere with this shrinkage, a portion of the duct may remain open, or, indeed, the entire duct may remain open to the umbilicus, or a portion may close and become the fibrous cord already described. Such disturbing influences may not affect this part of the body alone. The anomaly of this diverticulum has been found to coexist with transposition of the viscera, with hare-lip, with bicornate uterus, with spina bifida, with umbilical hernia, with absence



of cardiac septum, with atresia of the anus, with exstrophy of bladder, in anencephalous monsters, etc.

The diverticulum is found in other animals—in the ape, the dog, etc. The entire canal to the umbilicus may persist in the lower order of birds, as the gallatores, natatores, and, exceptionally, in the raptores and passerres; also in reptiles and cartilaginous fishes.

From what has been said, we would expect to find the diverticulum somewhere in the lower fourth of the small intestine. Accepting the usual statement that the small intestine is about 20 feet long, we should find the diverticulum in the last 5 feet—therefore in the ileum.

But what is the length of the small intestine? There are differences of statement. Macalister, excluding the duodenum, gives the length as 6.75 metres, or 22.25 feet; of this, he allows a third, or a little over 7 feet, to the jejunum, and somewhat over 15 feet to the ileum. Leidy gives 20 feet, adding that the length varies between 15 and 25 feet, and mentions the case of a man in whom the small intestine was 26.25 feet. Gegenbauer says 5.5 to 6.5 metres; equal to 18 to 21 feet. Krause gives 4.2 to 8.5 metres; but he says it is more commonly 5.5 to 6.2 metres, which makes it nearly the same as Gegenbauer. Krause allows two-fifths to the jejunum and three-fifths to the ileum. Allen says the jejuno-ileum measures 15 to 20 feet; two-fifths is jejunum and three-fifths ileum. Treves, quoted by Gray, "found, in 100 cases, the average in the male was 22.5 feet; female, 23.33 feet; but that in the male the measurements varied between 15.5 and nearly 32. In the infant it is 9.5 feet, and during the first two months it grows about 4 feet."

I must say that I have but little confidence in these measurements. In whatever way the intestine may be measured, it will stretch, especially if the mesentery be removed; and I do not see how the measurement can be taken unless the mesentery is removed. This stretching will, of course, give a greater length than the true one; but how much greater no one can tell. Some years since I helped to take measurements of the small intestine in 48 cases; 9 of the cases were nineteen years old and under. As, however, Treves thinks that age, height, and weight have nothing to do with the length, I will give the results regardless of age.<sup>1</sup>

Twenty-two, or nearly half the cases, showed a length of 24 to 26 feet. The largest number of these measured 25 feet, and we might, therefore, call this the average. But this is higher than any other averages I have seen. All these measurements, however, were taken

<sup>1</sup> The length of the small intestine was 15 feet in one case; 19 in one; 20 in two; 22 in two; 22.5 in one; 24 in five; 24.5 in one; 25 in eight; 25.5 in one; 26 in seven; 27 in one; 27.5 in one; 28 in two; 29 in five; 30 in one; 32 in four; 33 in three; 34 in one; 40 in one. I think this is enough variety—anywhere between 15 and 40 feet.

on negroes and mulattoes. It is just possible that this may be some explanation of the large figures. The large intestine was measured in the same series of cases.<sup>1</sup> In two-thirds of them it measured from 5 to 6 feet.

We will accept, however, the statement that 20 feet is the average length of the small intestine, and allow two-fifths to the jejunum and three-fifths to the ileum. Of course, the distinction between the lower jejunum and the upper ileum is arbitrary; nobody can say where one ends and the other begins, and the division by fifths is, therefore, probably as good as any division that can be made.

Most writers state that the communication of the ovo-vitelline duct is within the lower fourth of the small intestine, and also that the diverticulum is in the lower fourth—that is, in the lower five feet.<sup>2</sup>

An analysis of the 185 cases which I tabulated gives the following results: In 39, or 21 per cent., the diverticulum was found between the ileo colic valve and 1 foot above the valve.<sup>3</sup> In 20 cases, or 10 per cent., it was 1 or 2 feet above the valve.<sup>4</sup> In 22 cases, or 12 per cent., it was from 2 to 3 feet.<sup>5</sup> In 4 cases, from 3 to 4 feet; in 8 cases, from 4 to 5 feet; in 4 cases, from 5 to 6 feet; in 1 case, 10 feet above. In all, 98 of the 185 cases reported. In 62 other cases no measured distance was given, but the ileum is stated or implied.<sup>6</sup> These, added to the 98, make 160, or 86 per cent., in which the diverticulum was without doubt in the ileum.

Twenty-one cases remain in which the anomaly was said to have been

<sup>1</sup> 3.5 feet in two cases; 4.5 in eight; 5 in thirteen; 5.5 in eight; 6 in eleven; 7 in four; 8 in one.

<sup>2</sup> Macalister says: "The lower fourth, where the vitelline pedicle was attached." Osler says: "The beginning of the ileum;" this would be somewhere about 12 feet from the ileo-colic valve. Osler is certainly wrong as to the average. Albers says that the diverticulum is preferably in the ileum about the middle; this would be about 6 feet from the valve. Gegenbauer says one-half or one metre from the valve, that is, 1.5 to 3 feet. Ziegler says, one metre or more; Henle, 1.5 to 3 feet; Wilks, 2 to 3 feet; Allen, 3 feet. Cazin says it is always in the ileum, and within three feet of the valve. Förster, Rokitanski, and Ziegler did not find it in the jejunum.

<sup>3</sup> Eight of these, however, were infants between the time of birth and five months old, leaving 31 adults, or, where the age was not given, presumably adults. In 6 of these 39, it was stated that the anomaly was "at" or "near" or "just above" the valve.

<sup>4</sup> This includes 2 infants between birth and fourteen months, leaving 18, probably adults.

<sup>5</sup> Including one child three years old.

<sup>6</sup> It was simply stated to be "above the valve" in one case; "the usual place in ileum" in one; "lower ileum" in eighteen; "ileum" in thirty-two, including an eight months' fetus; "lower third of small intestine" in one; "junction of middle and lower thirds of small intestine" in two—both four months' fetuses; simply "small intestine" in seven.

I assume that by small intestine was meant the ileum; if these 7 are excluded, we still have 153.

in the jejunum or duodenum: duodenum, 7 cases; jejunum, 14. These deserve to be considered somewhat critically.

In 7 cases it was said that the anomaly was in the jejunum; in 1 case, in the middle of the jejunum; once, in the third or fourth inch; once, in the lower part. In 4 cases the jejunum was implied; as, once, where it was 2 feet from the pylorus; once, 40 inches from the duodenum; once, in the first 3 feet of the small intestine; once, 15 feet from the ileo-colic valve.

The reporters of these cases were as follows: One by Cornillon, Anatomical Society, Paris; one by Buzzi, *Virchow's Archiv*; one by Moore, London Pathological Society; one by Beale, London Pathological Society; two by Dr. Elliott Coues, in which he says "jejunum;" one by Clarkson and Collard, *Journal of Anatomy and Physiology*, London, who say, "in jejunum, 2 feet from pylorus;" one in the Museum of St. Bartholomew's Hospital; one in the Museum of Ft. Pitt, Chatham; one in the pathological catalogue of the College of Surgeons, London; two in Museum of the Medical College, Madras; one in St. George's Hospital Museum; one in Charing-Cross Hospital Museum. I see no reason to doubt the accuracy of these statements, although it is possible that one or more may not be correct.

As to the duodenum, 7 cases are reported. In 4 there is simply the statement that the anomaly was in the duodenum; in 1, in the upper part of the duodenum; in 1, in the middle; in 1, about 10 inches from stomach. One of the cases is reported by Albers in his work on *Pathological Anatomy*; he saw the anomaly in the transverse portion. The specimen in the St. George's Hospital Museum, London, is described as a rounded pouch on the duodenum; the 3 cases in the Pathological Museum, Royal College of Surgeons, London, as pouches on duodenum; no further details. There are 2 cases in the Army Medical Museum, Washington; published in the catalogue of 1867. One of these is from Dr. S. S. Bond, of Washington, and shows a diverticulum two inches long, evidently from the middle of the duodenum, from a dark mulatto, aged seventy-one; the mucous membrane of the pouch is distinct, but the outer walls are so thin that there is a doubt whether any muscular fibres are present. The second specimen was contributed by a Dr. W. C. Miner, U. S. Army, whom I personally knew, and who was in good repute as an anatomist and pathologist. The specimen is described as from the upper part of the duodenum, about ten inches from the stomach. These two statements are not consistent. An examination shows the specimen to be from the ileum; how low down I cannot say, but there are no valvulæ conniventes. How, or by whom, this mistake was made cannot now be ascertained, but that it is a mistake is beyond a doubt.

The 4 cases in the London Museums are too briefly described to warrant any expression of opinion other than that the statements are prob-



ably correct. The case of Albers must be admitted. Of the 2 specimens in the Army Medical Museum, I have shown that 1 is incorrectly described, it being really from the ileum. Of the other I can only say that I am not satisfied that it is a Meckel diverticulum.

I believe we must admit the possibility of the occurrence of this diverticulum in the jejunum and duodenum, but I also think that all reported cases, and the specimens when possible, should be carefully examined. I do not know of anything in the history of development to prevent the ovo-vitelline duct from opening into the intestine in other places than the lower part of the ileum. The fact that it usually does open here is apparently according to some law; that it may open elsewhere would then be simply an exception, and the exception does not appear to cause any marked disturbance of nutritive processes. Buzzi, above quoted, suggests that the connection of the duct near the cæcum may afterward, during development, "ascend to the jejunum." Whether there is an absolutely necessary relationship between the duct connection and the primitive fold of the intestine I do not know; this is an interesting and perhaps important question. So far as the analysis of cases shows, out of the 98 in which the distance from the ileo-colic valve is stated, in three-fifths the anomaly occurred within the first two feet of the ileum, above the valve; in more than four-fifths within the first three feet, so that it is fair to state that its usual place is within these three feet.

Eleven of the cases are reported as from children and fœtuses. The greatest distance from the valve in a child was 26 inches—in a child three years old. The next greatest was 20 inches—in a fourteen-months-old infant. The remaining cases were 13 inches or less. It would be fair to assume that in most infants and children it would be between 3 and 12 inches from the valve. The average length of the small intestine in the newborn infant, according to Treves, is 9.5 feet,<sup>1</sup> and he says it grows 4 feet in the first two months. In 1 of these 11 cases, in an infant five days old, the diverticulum was 10 inches from the valve; the reporter says the entire small intestine measured 60 inches; the anomaly was therefore at the junction of the fifth and sixth sixths.

Statements differ somewhat as to the frequency with which the diverticulum is found. Albers says about once in 1000 bodies examined. He never saw it in children. This percentage is much too small. Osler found it in 2 per cent., and this agrees with the result of the collective investigation of the Anatomical Society of Great Britain and Ireland, which was 16 times in 769 subjects. Mr. Rolliston, of St. George's Hospital, in 337 subjects found it 10 times; that is, 3.37 per cent. I

<sup>1</sup> This corresponds exactly with a measurement I have just made in a newborn infant: small intestine 9½, large 2 feet.



have no figures to offer from my own observation, not having always kept a record of the occurrence of the anomaly.

Another interesting question arises, namely, as to the relative frequency in the sexes. Although Rolliston examined about as many women as men, he found 9 of his 10 cases in males. I have nothing to offer on this point; the records are not sufficiently complete. Neither can an opinion of value be formed from the list I have tabulated. If there is a difference in the relative frequency there must be some explanation which, as yet we have not discovered.

Diverticula vary much in length. Henle says they are from  $\frac{1}{2}$  inch to 6 inches; Albers, 1 to 7; Cazin, 1 to 7 or 8. Most other writers give an average of 3 inches. Of the 185 cases collated, the length was stated in 109.<sup>1</sup> The analysis of the 109 cases gives the following result:

Infantile and fetal.	Adult.	Not stated.	Total.	
6	6	1	13	One inch long and under.
4	34	6	44	One to two inches long.
2	22	5	29	Two to three " "
...	5	10	15	Three to four " "
...	...	5	5	Four to five " "
...	...	2	2	Six inches long.
...	1	...	1	Seven inches long.
12	68	29	109	

The greatest length in an adult was 7 inches, a specimen from a sixteen-year-old boy; the greatest length in an infant, fourteen months old, was 3 inches. In 6 infants and foetuses, between four months' foetal and fourteen months' infantile life, the diverticulum was 1 inch and under in one half, and between 1 and 3 inches in the other half. In one-half the adults it was between 1 and 2 inches; in five-sixths between 1 and 3 inches. Of the entire 109 cases, the number of those in which it was between 1 and 2 inches long exactly equals those in which it was between 2 and 4 inches; giving an average, therefore, of 2 inches in length.

An interesting question is as to the presence of a cord attached to or near the apex of the diverticulum, the other end lying free in the abdominal cavity, or attached to the abdominal wall or to one of the viscera. Of the 185 cases tabulated, the cord was reported present in only 22, or 12 per cent. The meagreness of detail of some cases suggests that it probably existed oftener than stated. In no case was it said to lie free in the abdominal cavity, although in 3 its place of attachment, if any, is not mentioned. In 7 cases it was attached to the umbilicus, and in 2 others to the wall just below the umbilicus. In these 9 cases the distance from the ileo-colic valve varied from 8 to 24 inches; all

<sup>1</sup> In 8 others such expressions were used as large, small, size of bean, of horse-bean, pullet's egg, and hen's egg.

believed to be adults except one, which was an infant five days old. In 3 cases the length of the cord is given: 1 inch in 2 cases, 2 inches in 1 case. In 1 an artery in the cord was distinguished by the preservative injection used; in another there were three cords, answering to the duct, artery, and vein. Rollistou states that in none of the 10 cases reported by him did the cord extend to the umbilicus.

In 10 cases the cord was attached to the mesentery; in 1 to the ileum; in 1 to the ascending colon. Sometimes the cord was not mentioned, but the diverticulum was said to be attached to the omentum in 2 cases, in 1 to the mesentery, and in 1 to ileum. In this second group of 16 cases, the distance from the valve, where stated, exceeded 3 feet only once. The length of the cord was given 8 times, varying from  $\frac{3}{4}$  to 4 inches.

As is well known, disturbances of digestion and serious danger to life have been caused by diverticula. They may be invaginated, and unless this is relieved death will follow. Foreign bodies may lodge in them and set up inflammation and ulceration; sometimes perforation and fatal peritonitis. Typhoid ulceration may occur in them, and may be fatal. When they have a cord, the outer end of which is attached to some other part of the abdomen, this may cause strangulation of the intestine. Diverticula may lodge in hernial sacs and cause fatal disturbance.

Where the duct extends all the way to the umbilicus, and the latter is patulous, feces may be discharged from this opening. At least 4 cases of this kind are on record. One by Förster: a woman, aged thirty-four; small quantities of mucus and food had been discharged since her earliest childhood, but did not trouble her. The apex of the diverticulum was found attached to the inner side of the umbilicus and communicated externally. (See *Würzburg. med. Zeitschrift*, 1862, p. 205.) Another case by Gesenius—an infant; the navel string fell off, leaving an opening from which was discharged a little yellowish fluid and greenish intestinal contents. (*Journ. f. Kinderheilk.*, Erlangen, 1858, p. 56.) In the Museum catalogue of Guy's Hospital, London, are 2 cases: the apex of the diverticulum was attached in one to the umbilicus, in the other, near by; in each the feces were passed to some extent through the opening.